

Introduction

The regulated entities have large, complex balance sheets that include assets and liabilities with imbedded options. Many of the regulated entities have significant positions in derivatives, including swaps, options, and swaptions. Because of the complicated nature of their positions, these entities require models to identify, measure, and help manage their exposure to various types of risk; especially, market risk and credit risk. For market risk measurement, each entity uses numerous models to project the likely effects of interest rate changes on its market value of equity, on the prepayment rates on its mortgage-related assets, and on current and future earnings. Each entity also uses models to estimate the market value of instruments for which actual market prices are often unavailable. For credit risk, these entities use models to project expected future delinquencies, defaults, and losses and their exposure to the possibility of such losses in different possible economic environments. Given the importance of mortgage assets on their balance sheets, possible future house price paths are often a key feature of both market risk and credit risk models. This examination module has applicability in the examination of Fannie Mae, Freddie Mac, and the Federal Home Loan Banks (FHLBanks or Banks).

Risk Modeling examinations involve assessing the model risks in seven main areas: (i) measurement of interest rate risk exposure, (ii) measurement of credit risk exposure, (iii) modeling systems, (iv) modeling assumptions, (v) mortgage prepayment, (vi) mortgage default, and (vii) loss modeling. Part of these assessments is the independent model governance and model risk oversight provided by the regulated entities themselves. A thorough risk modeling examination uses a variety of models and model review procedures to test the regulated entities' risk-modeling capabilities. It will also ensure that the regulated entities are using models appropriately and with acceptable assumptions. Depending on the type of model, the risk modeling examination may include investigating the model-development process, model code, and the consistency across models used for similar purposes. The overarching goal of a risk modeling examination is to verify independently the model results produced by the regulated entities so that the FHFA can have confidence that the regulated entities identify, measure, and manage risks appropriately.

Regulatory Environment

The primary authorities governing, or relevant to, risk modeling at the regulated entities are set forth below. The examiner should ensure that the application of such authorities to a regulated entity has been considered by the regulated entity and its legal counsel.

- 1) Rules and Regulations of the Federal Housing Finance Board, which include 12 CFR 932.5, Market Risk Capital Requirement.***

2) ***Rules and Regulations of the Federal Housing Finance Agency (12 CFR Part 1236)*** –FHFA’s Prudential Management and Operations Standards (“PMOS”) establish standards that address 10 separate areas relating to management and operation of the regulated entities (internal controls and information systems, internal audit, interest rate risk, market risk, liquidity, asset and investment portfolio growth, asset management, overall risk management processes, credit and counterparty risk, and records maintenance). Standard 8 pertains to overall risk management, and requires sufficient controls around risk measurement models to ensure the completeness, accuracy, and timeliness of risk information. Standard 4 pertains to the risk measurement system and addresses market risk models. Standard 1 emphasizes the need for adequate internal controls and information systems. Standard 3 requires the development of an appropriate market risk strategy, risk limits and stress testing.

3) ***Advisory Bulletins of the Federal Housing Finance Board that provide supervisory guidance relating to the topic of modeling are the following:***

Advisory Bulletin 03-9, dated October 3, 2003, provides FHLBanks with a uniform methodology for calculating Duration of Equity (DOE) under a smaller parallel down shock when a full - 200 basis point shock would cause some rates to fall below 35 basis points (0.35 percent).

Advisory Bulletin 04-05, dated September 29, 2004, provides guidance to senior management and boards of directors of FHLBanks on risk limits for the management and control of interest-rate risk.

Advisory Bulletin 05-05, dated May 18, 2005, provides guidance about setting risk management oversight responsibilities for senior management and the Board of Directors.

Advisory Bulletin 05-06, dated June 10, 2005, outlines the process and describes the type of documentation required for an FHLBank to avail itself of the notification process to make changes to a previously approved internal market risk model.

Advisory Bulletin 03-10, dated October 6, 2003, provides the FHLBanks with guidance on a number of issues relating to the calculation of market value at risk (VaR) and market risk modeling.

Advisory Bulletin 09-03, dated December 15, 2009, provides guidance to model documentation and validation.

4) ***Other Government Agencies’ resources pertaining to model risk management and business continuity planning include:***

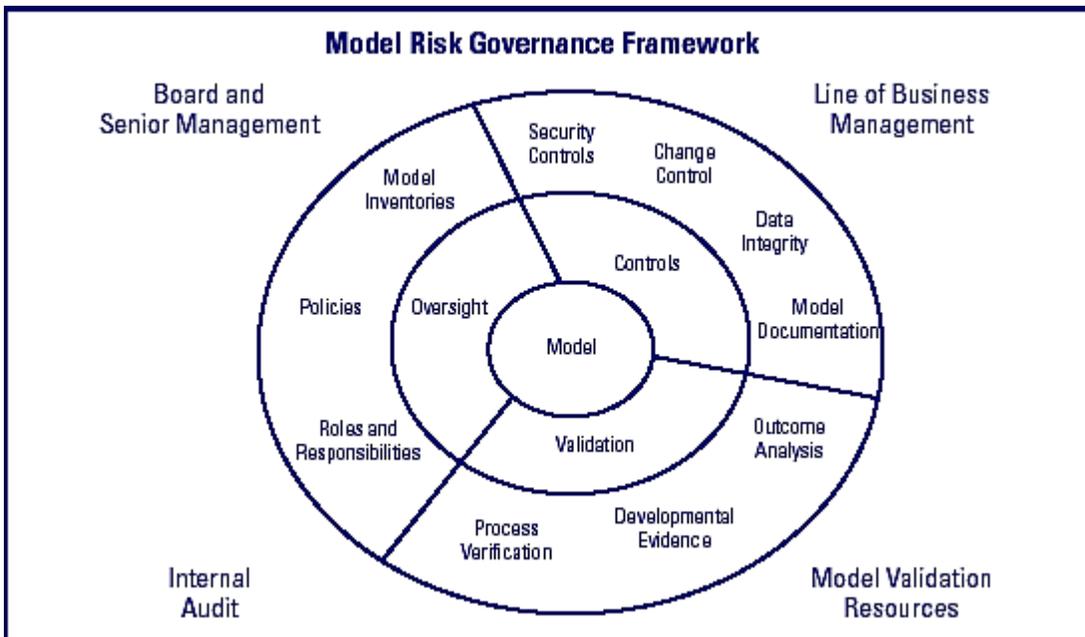
OCC 2011-12 Supervisory Guidance on Model Risk Management, dated April 4,

2011, provides a wide range of useful guidance for evaluating risk modeling at financial institutions.

Issues Specific to the Regulated Entities

The failure to address model risk or, at minimum, to understand its potential effects on the measurement of credit and market risk exposures, has the potential to result in poor business management decisions, particularly in volatile market environments. Without sound risk modeling, the regulated entities will not have accurate measures of their market risk exposures, risk metrics, or, more generally, of the sensitivity of their market value of equity (MVE) or income to changes in market interest rates. Similarly, effective risk modeling is essential for measuring exposure to credit risk such as potential credit losses related to the Enterprises’ pricing guarantees, making credit loss reserve decisions, assessing the likelihood of a FHLBank member failing, evaluating collateral supporting FHLBank advances, and making other important risk management decisions. Accurate measures of these risks and sensitivities are imperative in making effective credit and market risk management decisions.

Sound risk modeling and model governance includes not just the model, but model-related controls, policies and procedures, validation, and input and output analyses. The following illustration provides an overview of a useful model risk governance framework.



No model can take account of all possible events, nor can any risk modeling team or model developers keep perfect pace with changing market conditions or technical innovation. Moreover, reasonable people, considering perceived costs and benefits, can

disagree about the best way to model financial instruments or the best models to support management decision making. As a result, model developers, model validators, and business users of models make trade-offs and model risks arise. Potential sources of model risk include:

- 1) Use of a model to measure a risk for which it is not well designed;
- 2) Rapidly changing market conditions that make a formerly good model function poorly;
- 3) Modeling assumptions that might be unreasonable, even if they appeared reasonable only recently;
- 4) Implementation of flawed computational logic because of poor controls or insufficient understanding of an algorithm;
- 5) Flawed pre-processing procedures (e.g., data scrubbing rules, data pooling) that lead to error-prone input data;
- 6) Processes and controls for the data that feed into the models. Such data include market data and data on the positions (e.g., assets, liabilities, and derivatives);
- 7) Lack of computational transparency;
- 8) Model calibration;
- 9) Model assumptions, including:
 - a) Choice of discount curves, and spreads, for discounting different types of cash flows;
 - b) Distributions of potential rate paths used for modeling complex advance, debt and swap instruments;
 - c) House price changes;
 - d) Macroeconomic performance;
 - e) Prepayment tuning parameters; and
 - f) Loss severity assumptions.
- 10) Inappropriate probabilistic measures used to assess the likelihood of an adverse credit event;
- 11) IT capacity and controls to run the models and process the results efficiently;
- 12) Education level and modeling experience at the regulated entities;
- 13) Adequacy of the documentation and IT controls to support the models and model changes, such as change logs for changes to models or model assumptions;
- 14) Adequacy of policies and procedures for model-related issues, such as model validation, back-testing and error tracking;
- 15) Post-processing errors in the reporting of model results;
- 16) Priority given to the importance of model risk and to ensuring that models are well-governed and validated on a regular basis; and
- 17) Defined roles and responsibilities of model stakeholders (i.e., model developers, model users, model validators, and committee oversight).

Common Risk Mitigation Practices for Model Risk

The regulated entities should have significant controls over their model risk. Such controls include:

- 1) Validation of model inputs against the general ledger or other source data;
- 2) Validation of the processing components of models; calibration, securities valuation, etc.;
- 3) Annual independent model validation reports for mission critical models;
- 4) IT change control procedures;
- 5) Back-testing the model's results against actual results;
- 6) External benchmarking – comparing model results to external, third-party model results or other internal models;
- 7) Policies and procedures for model validation, model change, and testing;
- 8) Documentation that specifies strengths and weaknesses of models for their potential uses;
- 9) Documentation that specifies “downstream” uses of the each model's output;
- 10) Policies and procedures for reporting potential risk measurement problems resulting from model risk;
- 11) Policies and procedures for making adjustments to unreasonable model results;
- 12) Regular reports of model performance and policies and procedures for reporting to management errors in excess of identified thresholds;
- 13) Effective and transparent model risk governance, including committees structured with the authority to implement model risk policies, corresponding policies and procedures, formal roles and responsibilities clearly defined for all model stakeholders, and adequate information flows and reporting among model developers, users, validators and oversight committees; and
- 14) A model inventory that captures, at a broad level, key model-related information. The inventory should list, at minimum, (i) the models that are in production, (ii) a risk ranking of the model, and (iii) the model owner. Other information the entity should maintain includes (not necessarily in the inventory): the model objective(s); any component models; primary uses; principal inputs (type and source); principal outputs (type and source); downstream dependencies; impact analysis, and the last date of an independent review.

Examination Guidance

The workprogram for the Risk Modeling examination module is detailed below. If this module is included in the examination scope, the examiner must perform worksteps sufficient in coverage to document the basis for conclusions on the quantity of risk and quality of risk management pertaining to this area. Transaction testing, however, is mandatory and must evidence sufficient worksteps from Section 4, *Testing*, to support the findings and conclusions from this examination module.

In determining the extent of review and testing to be conducted in completing each examination, the examiner should take into account applicable FHFA off-site monitoring or analysis reports, such as analyses of the quality and effectiveness of corporate governance practices, financial condition and performance, economic and housing industry conditions, internal controls, and audit coverage relating to the institution's risk modeling activities.

NOTE: Text in (*italics*) referenced in a workstep represents illustrative guidance that serves as suggestions for specific inquiry.

1. Scope of Examination Work Performed

Determine the scope of the model examination by first consulting the supervisory strategy that identifies the risk areas under consideration. Then identify the relevant model(s) and risks the model(s) measures. Prepare a summary of the actual work to be completed as part of the examination.

Understanding the significance of model risk requires an understanding of the business uses of model results. Although, to some extent, an examiner will not be able to understand fully the model risks until he or she has completed the examination, the following pre-exam work should help in setting the scope:

- 1) Review past reports of examination for outstanding issues or previous problems related to risk modeling.
- 2) Review FHFA offsite monitoring or analysis reports, and workpapers produced as part of ongoing monitoring relating to Risk Modeling.
- 3) Assess the status of outstanding Matters Requiring Attention and Violations pertaining to risk modeling. Review any prior work by FHFA that pertains to the

model or models under examination, review the prior year's examination scope, and discuss issues with appropriate examination and other personnel.

- 4) Review internal audit reports for outstanding issues relating to risk modeling.
- 5) Review minutes of meetings of the board of directors and relevant board and management committees for any issues regarding risk modeling.
- 6) Request from the regulated entity preliminary documentation to determine the examination scope and commence examination work. These documents may include any combination of the following:
 - a) Model inventory;
 - b) Most recent independent, model validation report;
 - c) Documentation describing the model, model development, , and use (and limitations on use);
 - d) List of modeling assumptions (e.g., discount curves, spreads, interest rate processes, house price paths, etc.) as appropriate for all modeled instruments;
 - e) Most recent committee (e.g., Asset-Liability Committee, Valuation Committee, Credit Committee) reports in which model results are discussed;
 - f) Written procedures for modeling the financial instruments including for example any pooling or sorting rules and any procedures for adjusting model results.
 - g) Testing results (e.g., stress, sensitivity);
 - h) Performance tracking and monitoring reports;
 - i) Enterprise risk management policy (or other documents) that discusses the roles and responsibilities, committee structure, and reporting standards for model risk governance;
 - j) Specific terms, conditions and balance sheet positions for the instruments that may be selected for testing; and
 - k) SARBOX or other regulated entity diagrams or flow charts pertaining to the model's data and inputs, the model, and the model outputs.
- 7) If the regulated entity has implemented a new model or made significant changes to an existing model, determine if proper approval from FHFA was required and, if so, obtained. *(If approval was required but not obtained, consider modifying the scope of the examination and request the proper documentation from the regulated entity for approval.)*
- 8) Based on the review of the documents provided, and in consultation with relevant members of the examination team, prepare a description of planned activities for the model examination.

Summarize the work performed in the examination of the institution's risk modeling area. To the extent there were modifications to the originally planned scope based on concerns identified during the examination, document those changes and the reasons for such changes.

2. Description of Risks

Based on the work described above for setting the scope of the model exam, develop a plan for examination work that focuses on key model risks in terms of their potential effects on business decisions. The point of the model examination is not simply to identify modeling concerns but to identify modeling concerns that are correctable (based on an understanding of current standard and best practices) and that could cause significant risk of financial loss if not corrected. If modeling concerns are not readily correctable, determine whether the entity is making reasonable adjustments to control the potential problem that is the focus of the concern. Determine whether modelers and business managers whose decisions depend on the model understand these risks and how they manage them. Also, determine whether appropriate model risk oversight is in place.

Materiality is another factor that can help identify key model risk. Examiners should give more attention to model risk that has the potential to significantly affect the financial reporting of the entity. The examiner should discuss the issue of materiality for a particular model with the EIC or appropriate managers.

3. Risk Management

Risk Identification Process

- 1) Based on work completed in the steps above, determine if the regulated entity has appropriately identified risks associated with risk modeling. (*In addition to potential weaknesses which could affect risk modeling directly, consider how an inadequate risk modeling function could adversely affect the evaluation of risk and potential risk mitigation practices in various areas of the organization including market risk, credit risk, operational risk, and the on-going evaluation of the institution's financial condition and performance.*)

Organizational Structure

Consider steps taken by the regulated entity to mitigate risk. Elements of a risk mitigation strategy would include:

- 1) A strong organizational structure with appropriate independence: Evaluate and conclude on the regulated entity's:
 - a) Functional organization and reporting structure;
 - b) Key personnel;
 - c) Primary duties, responsibilities, and technical expertise of personnel;
 - d) Segregation of duties;
 - e) Cross-training of personnel;
 - f) Coordination with other departments;
 - g) Significant changes in the foregoing since the last examination; and
 - h) Oversight responsibilities of the modeling group.

Policy and Procedure Development

- 1) Evaluate and conclude on the appropriateness of establishment of risk tolerances and development of key policies and oversight by the board of directors. Evaluate the adequacy of senior management oversight and the risk management function for risk modeling activities, which may include the following:
 - a) Input of the division primarily responsible for the model under examination into decisions about risk limits made by senior management and the board of directors.
 - b) Communication to the modeling staff of the regulated entity's risk limits.
 - c) Policies and procedures for reporting of violations of risk limits or triggers to senior management and other relevant divisions of the regulated entity;
 - d) Model validation governance to ensure appropriate scope of model validation contracts and reports, independent parties have the skills to conduct the validations, and experienced internal staff to follow-up on validation report recommendations for remediation. *(If the regulated entity's staff does not have the expertise to complete the model validation process, has the institution made use of qualified third-parties to complete the work?)*
 - e) Comparisons of base-case results (e.g., security prices, OAS) to third-party (e.g., Bloomberg or Barclays) results; and
 - f) Model change guidance regarding change approvals, reporting of changes, and effects to key risk metrics.

- 2) Key policies and procedures, which may include those relating to the following:

Modeling Assumptions:

- a) Review modeling assumptions for internal consistency as well as consistency with industry practices;
- b) Where appropriate to the model, review the choice of discount curves and spreads for discounting different types of cash flows;

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- c) Review assumptions used in modeling complex advance, debt, and swap instruments;
 - d) Review credit-related assumptions, such as house price paths, prepayment speeds, loss severities, and collateral maintenance levels; and
 - e) Review the accuracy of input data.

Risk Metrics

- 1) Review any risk metrics established by the regulated entity for which risk modeling results serve as the basis, and determine the entity's compliance with the metrics. *(In coordination with examiners evaluating other risk areas, determine if the metrics are appropriate for the potential risk exposure to the institution. Is information from the risk modeling area used to determine compliance with the standards established? If so, is the information accurate? Have any weaknesses in the risk modeling area adversely affected the institution's monitoring of compliance with risk metrics?)*

Reporting

- 1) Determine the adequacy of the regulated entities' model risk reporting. *(Are risks related to modeling appropriately identified and are these risks and the risk mitigation steps taken in response to these risks appropriate?)*
- 2) Determine if information reported to the board and management has been reliable. Determine if any deficiencies in the institution's risk modeling area have resulted in inaccurate or inadequate reporting of potential risk to the board or management.
Internal/External Audit
 - 1) Testing performed by external and internal auditors and outside consultants
 - a) Evaluate the testing performed by external or internal auditors of the model under examination and determine whether it is reliable; and
 - b) Evaluate the testing performed by outside consultants of the model under examination and determine whether it is reliable. *(Is testing sufficient to ensure potential risks have been identified?)*
 - 2) Risk assessment under 12 CFR 917.3(c) and internal control evaluation under the Sarbanes-Oxley Act (SARBOX)
 - a) Determine whether the model under review is identified in the annual risk assessment required under 12 CFR 917.3(c). Discuss the risk assessment with the EIC, and
 - b) Where appropriate, evaluate the effectiveness of the evaluations conducted pursuant to the Sarbanes Oxley Act (SARBOX) that identify the key risks and controls pertaining to financial reporting and evaluate potential fraud, and

procedures implemented to periodically attest to the adequacy of the control environment around the model under review.

Information Technology

- 1) Information technology and controls
 - a) Identify and assess:
 - i. Pertinent automated and manual systems;
 - ii. Applicable controls over authorized users and the use of spreadsheets and EUCs; and
 - iii. Vendor technical support.
- 2) Identification and evaluation of controls and significant changes to the activity or function.
 - a) Evaluate workflow and processes as well as controls, including the level and direction of risk and the quality of risk management; and
 - b) Evaluate any significant changes (e.g., management, systems, key personnel, regulatory requirements and processing) that the regulated entity has implemented since the last examination, or is considering implementing, that may affect the entity's risk profile. (*What effects have such changes had on the modeling area and the potential to the reliability of modeling results?*)

Compliance

- 1) Evaluate and conclude on the efforts of the regulated entity to ensure compliance with regulatory guidance related to risk modeling. Determine if the institution has submitted appropriate information for and received approval for approval of models and modifications to models as required by FHFA.
- 2) Assess and concluded on compliance with PMOS Standards 1, 3, 4, and 8 to determine if the regulated entity has established appropriate market risk limits and whether the institution's information system is adequate to monitor compliance with those limits and identify potential threats from market risk exposure.

4. Testing

- 1) Where appropriate, use FHFA-licensed software and models to obtain comparison estimates of regulated entity model results. For example, the examiner could use FHFA models to generate comparative results for the sensitivity of instrument or portfolio valuations to changes in interest rates or to alternative prepayment model

assumptions. When possible, check questionable results against other sources.

- 2) When possible, test documentation of model use procedures and oversight procedures by determining whether they are followed in practice.
- 3) Determine whether the uses of models in practice are consistent with the designed purposes of the model as documented.

5. Conclusions

- 1) Summarize conclusions for all examination work performed, including work performed by other FHFA staff as it relates to the regulated entity's risk modeling function. Develop a memorandum describing the risks to the institution resulting from risk modeling practices and the regulated entity's management of those risks. The memorandum should clearly describe the basis of examination conclusions reached and summarize the supporting analysis. Discuss the types of risk the model was developed to address and the quality of risk management practices (strong, adequate, weak).
- 2) Conclude on the responsiveness to previous examination findings pertaining to the model under review if within the scope of the examination. Evaluate the adequacy of the regulated entity's response to previous examination findings and concerns.
- 3) Develop findings and prepare findings memoranda, as appropriate. Based on examination work performed, develop findings communicating concerns identified during the examination. Findings should identify the most significant risks to the institution and the potential effect to the regulated entity resulting from the concerns identified. Such documents should describe a remediation plan specifying the appropriate corrective action to address examination concerns and establish a reasonable deadline for the regulated entity to remediate the finding. Communicate preliminary findings to the EIC. Discuss findings with regulated entity personnel to ensure the findings are free of factual errors or misrepresentations in the analysis.
- 4) Develop a list of follow-up items to evaluate during the next annual examination. In addition to findings developed in the steps above, include concerns noted during the examination that do not rise to the level of a finding. Potential concerns include issues the regulated entity is in the process of addressing, but require follow-up work to ensure actions are completed appropriately. In addition, potential concerns should include anticipated changes to the institution's practices or anticipated external changes that could affect the institution's future risk modeling practices.

Workprogram

1. Scope of Examination Work Performed

Workpapers must document the examination activities undertaken to evaluate potential risks in this area.

2. Description of Risks

- Identify areas of concern in risk modeling
- Assess current risks and trends in the risk to the organization emanating from the risk modeling area
- Evaluate changes within the organization or industry affecting risk
- Evaluate the entity's own risk-identification practices and conclude on their adequacy

3. Risk Management

- Assess and conclude on the adequacy of the organization's risk identification process
- Assess and conclude on the overall adequacy of internal controls, including an evaluation of:
 - The regulated entity's organizational structure
 - Policy and procedure development for risk modeling
 - Appropriateness of risk metrics established in risk modeling
 - Reporting by management and the board
- Assess and conclude on the internal and external audit of risks
- Assess and conclude on the adequacy of information technology and controls related to risk modeling
- Assess and conclude on the adequacy of the organization's efforts to ensure:
 - Compliance with laws, regulations and other supervisory guidance
 - Compliance with the organization's policies and procedures

4. Testing

- Complete testing, as appropriate, to assess adherence with applicable standards

5. Conclusions

- Summarize conclusions for all examination work performed related to risk modeling
 - Conclude on the level of risk to the organization
 - Include an assessment of the adequacy of an organization's monitoring of risk and establishment of internal controls to mitigate risk
- Conclude on responsiveness to examination findings from previous examinations
- Develop findings and Matters Requiring Attention, as appropriate
- Identify areas requiring follow-up examination activities or monitoring